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TRANSMITTAL LETTER TO THE UNITED STATES

0264-0002

DESIGNATED/ELECTED OFFICE (DO/EO/US)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

CONCERNING A FILING UNDER 35 U.S.C. 371

To Be Assigned **09/787641**INTERNATIONAL APPLICATION NO.
PCT/ZA99/00094INTERNATIONAL FILING DATE
17-September-1999PRIORITY DATE CLAIMED
05-October-1998

TITLE OF INVENTION

Biodegradable Middle Distillates and Production Thereof

APPLICANT(S) FOR DO/EO/US

De Haan, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

1. Copy of International Publication No. WO00/20534;
 2. Form PCT/IB/308; 3. Form PCT/IB/332;
 4. Form PCT/IB/301; 5. Form PCT/IB/304;
 6. Form PCT/IB/359; 7. Form PCT/ISA/202;
 8. Form PCT/IPEA/402; 9. Form PCT/RO/144;
 10. Copy of PCT Demand; 11. Copy of the PCT Request; and
 12. Postcard.

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.53) To Be Assigned 09/178764T	INTERNATIONAL APPLICATION NO. PCT/ZA99/00094	ATTORNEY'S DOCKET NUMBER 0264-0002
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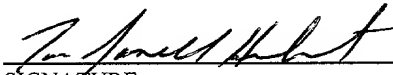
21. The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$970.00					
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$840.00					
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$690.00					
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$670.00					
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$96.00					
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$840.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	48 - 20 =	28	x \$18.00	\$504.00	
Independent claims	2 - 3 =	0	x \$78.00	\$0.00	
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$1,344.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable) <input type="checkbox"/>				\$0.00	
SUBTOTAL =				\$1,344.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$1,344.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable) <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$1,344.00	
				Amount to be:	\$
				refunded	\$
				charged	\$

- ☒ A check in the amount of **\$1,344.00** to cover the above fees is enclosed.
- ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.
- ☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **50-0622** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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03/21/01
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BIODEGRADABLE MIDDLE DISTILLATES AND PRODUCTION THEREOF**Field of the Invention**

- 5 This invention relates to middle distillates having biodegradability properties and to a process for production of such distillates. More particularly, this invention relates to middle distillates produced from a mainly paraffinic synthetic crude which is produced by the reaction of CO and H₂, typically by the Fischer-Tropsch (FT) process.

10 Background to the invention

- In recent years a trend has developed to produce products which are so called "environmentally friendly", one aspect of which is biodegradability. To this end various bodies, such as ISO and the OECD have developed test methods to quantify biodegradability. One such test is the CO₂ evolution
15 test method, also known as the modified Sturm OECD method 301B, which test for ready biodegradability. In terms of this test, compounds can be considered to be readily biodegradable if they reach 60% biodegradation within 28 days.

- Currently available middle distillates, typically crude oil derived diesel fuels, such as US 2-D grade
20 (low sulphur No. 2-D grade for diesel fuel oil as specified in ASTM D 975-94) and/or CARB (California Air Resources Board 1993 specification) grade diesel, do not meet the biodegradability requirements of the abovementioned biodegradability test.

- The prior art teaches in ZA 96/9890 that high biodegradability of hydrocarbon base oils could be
25 derived from the presence of predominantly mono-methyl branching on the paraffinic carbon backbone. US 5,498,596 discloses a non-toxic, biodegradable well fluid comprising 98% (mass) n-paraffins and less than 1% (mass) monocyclic aromatics as well as other olefinic components. The biodegradability of the well fluid in the US patent can not be related back to the nature of the paraffinic molecules due to the fact that biodegradability is enhanced through branching and not
30 through linear n-paraffinic molecules. Further, WO 92/14804 discloses a low aromatic diesel fuel which comprises mainly a mixture of hydrocarbons containing not more than 1% by volume of aromatic type hydrocarbons and less than 0.05% sulfur or sulfur compounds. The fuel is disclosed as reducing unwanted emissions and improving operational performance. The disclosure however does not address the issue of biodegradability. Still further, WO 97/14760
35 discloses diesel fuels having excellent lubricity, oxidative stability and high cetane number produced from the non-shifting Fischer-Tropsch process. Again no mention is made regarding

biodegradability and the disclosure of oxidative stability would indicate against biodegradability.

5 A need thus exists for a middle distillate cut, typically a diesel fuel, which is readily biodegradable as determined by the abovementioned biodegradability test.

Surprisingly, it has now been found, that a low aromatics content and a relatively high iso-paraffins to n-paraffins ratio contributes to ready biodegradability of middle distillates, such as diesel fuel.

10 Summary of the invention

Thus, according to a first aspect of this invention, there is provided a biodegradable middle distillate cut, such as a diesel fuel, having an aromatics content of less than 9 mass%, as determined by the ASTM D 5186 or IP 391 test method.

15 The synthetic middle distillate cut may have less than 8.99 mass% ~~total~~ monocyclic aromatics content.

The synthetic middle distillate cut may have less than 0.01 mass% ~~total~~ polycyclic aromatics.

20 The synthetic middle distillate cut may have an isoparaffins to n-paraffins mass ratio of between about 1:1 to about 12:1, typically the isoparaffins to n-paraffins mass ratio is between about 2:1 to about 6:1, and in one embodiment is 4:1.

25 The synthetic middle distillate cut may be a FT process product, or be at least partially produced in accordance with the FT process and/or process philosophy.

30 According to a second aspect of the invention, the synthetic middle distillate cut includes more than 50 mass% isoparaffins, wherein the isoparaffins consist predominantly of methyl and/or ethyl and/or propyl branched isoparaffins.

The gradient of an isoparaffins to n-paraffins mass ratio profile of the synthetic middle distillate cut may increase from about 1:1 for C₈ to 8.54:1 for C₁₅ and decrease again to about 3:1 for C₁₈.

35 Typically, a fraction of the synthetic middle distillate cut in the C₁₀ to C₁₈ carbon number range has a higher ratio of isoparaffins to n-paraffins than a C₈ to C₉ fraction of the synthetic middle distillate cut.

The isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction may be between 1:1 and 9:1.

5 The isoparaffins to n-paraffins mass ratio may be 8.54:1 for a C₁₅ fraction of the synthetic middle distillate cut.

A C₁₉ to C₂₄ fraction of the middle distillate cut may have a narrow mass ratio range of isoparaffins to n-paraffins of between 3.3:1 and 5:1, generally between 4:1 and 4.9:1.

10 The mass ratio of isoparaffins to n-paraffins may be adjusted by controlling the blend ratio of hydrocracked to straight run components of the synthetic middle distillate cut. Thus, the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 30% straight run component may be between 1:1 and 2.5:1.

15 The isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 20 mass% straight run component may be between 1.5:1 and 3.5:1.

20 The isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 10 mass% straight run component may be between 2.3:1 and 4.3:1.

The isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having substantially only a hydrocracked component may be between 4:1 and 9:1

25 At least some of the isoparaffins of the middle distillate cut may be methyl branched.

Typically, wherein at least some of the isoparaffins are di-methyl branched.

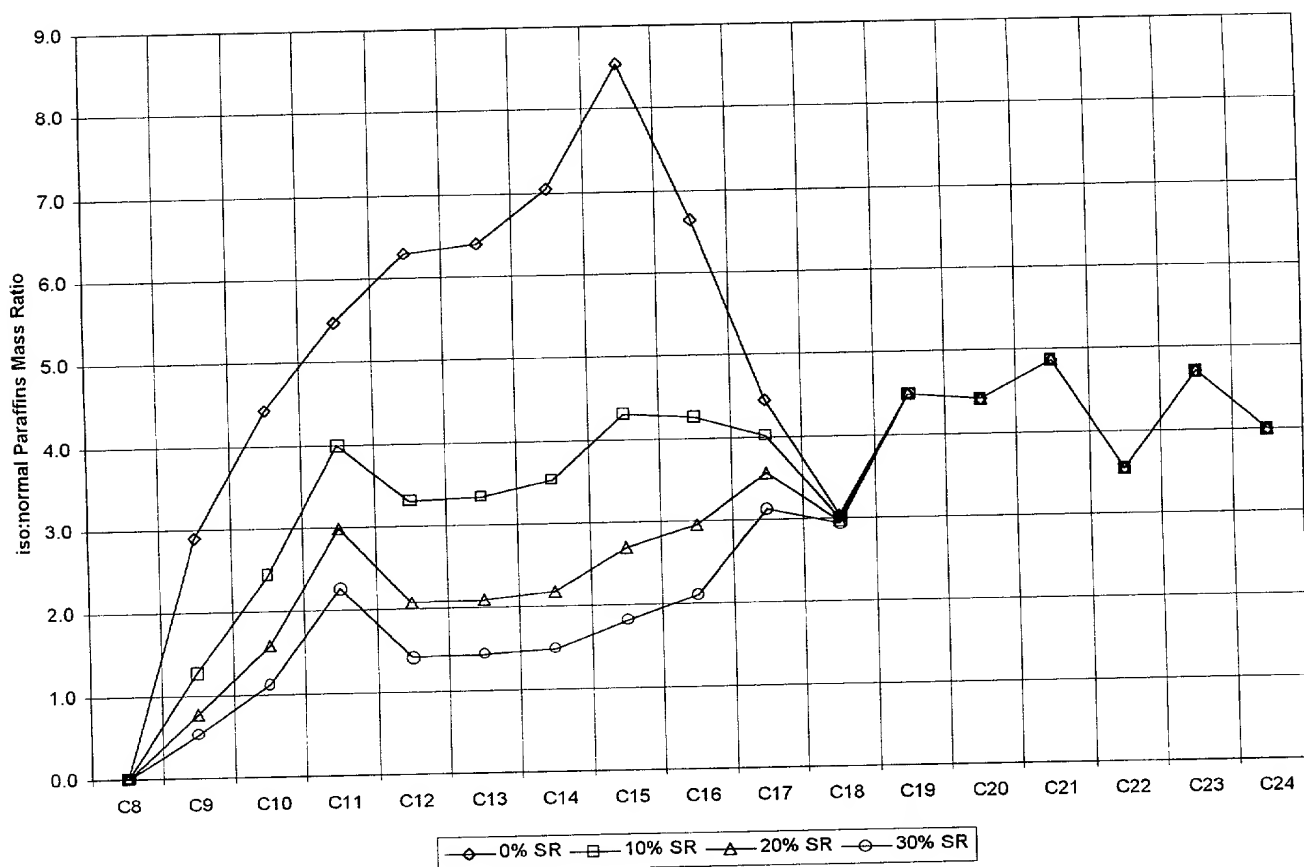
In a useful embodiment, at least 30 mass% of the isoparaffins are mono-methyl branched.

30 Some of the isoparaffins may be ethyl branched, or even propyl branched.

Table A: Comparison of the Branching Characteristics of Blends of SR ,HX and SPD Diesels

35 In the table: SPD – Sasol Slurry Phase Distillate
SR – Straight Run
HX – Hydrocracked

Branching Characteristics of FT Diesel



According to a third aspect of the invention, there is provided a biodegradable synthetic middle distillate cut, having an aromatics content substantially as described above.

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According to a fourth aspect of the invention, there is provided a biodegradable synthetic middle distillate cut, having an isoparaaffinic content substantially as described above.

The invention extends to a biodegradable synthetic middle distillate cut, having an isoparaaffinic content and an aromatics content substantially as described above.

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The biodegradable synthetic distillate may be a FT product.

According to a fifth aspect of the invention, there is provided a biodegradable diesel fuel composition including from 10 mass% to 100 mass% of a middle distillate cut as described above.

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The biodegradable diesel fuel composition may include from 0 to 90 mass% of another diesel fuel, such as conventional commercially available diesel fuel.

The biodegradable diesel fuel composition may include from 0 to 10 mass% additives.

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The additives may include a lubricity improver.

The lubricity improver may comprise from 0 to 0.5 mass% of the composition, typically from 0.00001 mass% to 0.05 mass% of the composition. In a particularly useful embodiment, the lubricity

10 improver comprises from 0.00 mass% to 0.02 mass% of the composition.

The biodegradable diesel fuel composition may include a crude oil derived diesel, such as US 2-D grade diesel fuel and/or CARB grade diesel fuel, as the other diesel fuel of the composition.

15 According to yet another aspect of the invention, there is provided a process for producing a readily biodegradable synthetic middle distillate, the process including:

- (a) separating the products obtained from synthesis gas via the FT synthesis reaction into one or more heavier fraction and one or more lighter fraction;
- (b) catalytically processing the heavier fraction under conditions which yield mainly middle distillates;
- (c) separating the middle distillate product of step (b) from a light product fraction and a heavier product fraction which are also produced in step (b); and
- (d) blending the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof.

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The catalytic processing of step (b) may be a hydroprocessing step, for example, hydrocracking.

The process for producing a synthetic middle distillate may include one or more additional step of fractionating at least some of the one or more lighter fraction of step (a), or products thereof, prior to step (d).

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The process for producing a synthetic middle distillate may include the additional step of hydrotreating at least some of the one or more light fraction of step (a), or products thereof, prior to step (d).

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The one or more heavier fraction of step (a) may have a boiling point above about 270°C, however, it may be above 300°C.

The one or more lighter fraction may have a boiling point in the range C₅ to the boiling point of the heavier fraction, typically in the range 160°C to 270°C.

- 5 The product of step (d) may boil in the range 100°C to 400°C. The product of step (d) may boil in the range 160°C to 370°C.

10 The product of step (d) may be obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of between 1:1 and 9:1, typically 2:1 and 6:1, and in one embodiment, in a volume ratio of 84:16.

15 The product of the above process may be a synthetic middle distillate cut, or products thereof, or compositions thereof, as described above.

The product of step (d) may be a diesel fuel.

20 A biodegradable diesel fuel produced in accordance with this invention may be produced from a mainly paraffinic synthetic crude (syncrude) obtained from synthesis gas (syngas) through a reaction like the FT reaction.

25 The FT products cover a broad range of hydrocarbons from methane to species with molecular masses above 1400; including mainly paraffinic hydrocarbons and much smaller quantities of other species such as olefins and oxygenates. Such a diesel fuel could be used on its own or in blends to improve the quality of other diesel fuels not meeting the current and/or proposed, more stringent fuel quality and environmental specifications.

30 The invention extends to an essentially non-polluting, readily biodegradable diesel fuel composition comprising of a mixture of normal paraffins (n-paraffins) and iso-paraffins in the typical diesel range from 160-370°C, having an iso-paraffin:n-paraffin mass ratio from about 2:1 to about 12:1, more typically from 2:1 to 6:1, and the iso-paraffins of the mixture contain greater than 30 mass%, based on the total mass of the iso-paraffins in the mixture, of mono-methyl species, with the balance consisting mainly of ethyl and/or dimethyl branched species. These iso-paraffins contained in a mixture with minor amounts of aromatics and other materials, contribute to a product from which
35 readily biodegradable diesel fuels can be obtained.

Claims:

1. A synthetic middle distillate cut having less than 9 mass%, as determined according to IP 391 or ASTM D 5186 standards, aromatics content, the synthetic middle distillate cut having less than 8.99 mass% monocyclic aromatics content and less than 0.01 mass% polycyclic aromatic content.

~~2. A synthetic middle distillate cut as claimed in claim 1 having less than 8.99 mass% monocyclic aromatic content.~~

~~3. A synthetic middle distillate cut as claimed in claim 1 or claim 2, having less than 0.01 mass% polycyclic aromatics.~~

4.2. A synthetic middle distillate cut as claimed in any one of the preceding claims 1, having an isoparaffins to n-paraffins mass ratio of between about 1:1 to about 9:1.

~~5.3.~~ A synthetic middle distillate cut as claimed in claim 4.2, wherein the isoparaffins to n-paraffins mass ratio is between about 2:1 to about 6:1.

~~6.4.~~ A synthetic middle distillate cut as claimed in claim ~~5.2~~, wherein the isoparaffins to n-paraffins mass ratio is 4:1.

~~7.5.~~ A synthetic middle distillate cut as claimed in any one of the preceding claims 1, wherein the synthetic distillate is derived from a FT primary product.

~~8.6.~~ A synthetic middle distillate cut as claimed in claim 2-, comprising more than 50 mass% isoparaffins, wherein the isoparaffins are predominantly methyl and/or ethyl and/or propyl branched.

~~9.7.~~ A synthetic middle distillate cut as claimed in claim ~~8.2~~, wherein the gradient of an isoparaffins to n-paraffins mass ratio profile of the synthetic middle distillate cut increases from about 1:1 for C₈ to 8.54:1 for C₁₅ and decrease again to about 3:1 for C₁₈.

~~10.8.~~ A synthetic middle distillate cut as claimed in claim ~~9.7~~, wherein a fraction of the synthetic middle distillate cut in the C₁₀ to C₁₈ carbon number range has a higher ratio of isoparaffins to n-paraffins than a C₈ to C₉ fraction of the synthetic middle distillate cut.

~~11.9.~~ A synthetic middle distillate cut as claimed in claim ~~9.8~~ or claim ~~10~~, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction is between 1:1 and 9:1.

~~12.10.~~ A synthetic middle distillate cut as claimed in claim ~~11.7~~, wherein the isoparaffins to n-paraffins mass ratio is about 8.54:1 for a C₁₅ fraction of the synthetic middle distillate cut.

~~13.11.~~ A synthetic middle distillate cut as claimed in any one of claims 8 to ~~12.7~~, wherein a C₁₉ to C₂₄ fraction of the middle distillate cut has a mass ratio range of isoparaffins to n-paraffins of between 3.3:1 and 5:1.

12. A synthetic middle distillate cut as claimed in claim 11, wherein the C₁₀ to C₁₈ fraction of the middle distillate cut has a mass ratio range of isoparaffins to n-paraffins of between 4:1 and 4.9:1.

- 44.13. A synthetic middle distillate cut as claimed in ~~any one of claims 8 to 137~~, wherein the mass ratio of isoparaffins to n-paraffins is adjusted by controlling the blend ratio of hydrocracked to straight run components of the synthetic middle distillate cut.
- 5 45.14. A synthetic middle distillate cut as claimed in claim 143, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 30 mass% straight run component is between 1:1 and 2.5:1.
- 46.15. A synthetic middle distillate cut as claimed in claim 134, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 20 mass% straight run component is between 1.5:1 and 3.5:1.
- 10 47.16. A synthetic middle distillate cut as claimed in claim 143, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 10 mass% straight run component is between 2.3:1 and 4.3:1.
- 15 48.17. A synthetic middle distillate cut as claimed in claim 134, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having substantially only a hydrocracked component is between 4:1 and 9:1.
- 20 ~~49. A middle distillate cut as claimed in any one of claims 8 to 18 wherein at least some of the isoparaffins are methyl branched.~~
- 25 20.18. A middle distillate cut as claimed in ~~any one of claims 68 to 19~~, wherein at least some of the isoparaffins are di-methyl branched.
- 20 21.19. A middle distillate cut as claimed in ~~any one of claims 68 to 20~~, wherein at least 30 mass% (mass) of the isoparaffins are mono-methyl branched.
- 22.20. A middle distillate cut as claimed in ~~any one of claims 8 to 21~~19, wherein at least some of the isoparaffins are ethyl branched.
23. ~~A biodegradable synthetic middle distillate cut, having an aromatics content substantially as claimed in any one of claims 1 to 7.~~
24. ~~A biodegradable synthetic middle distillate cut, having an isoparaflinic content substantially as claimed in any one of claims 8 to 22.~~
25. ~~A biodegradable synthetic middle distillate cut having an isoparaflinic content as claimed in claim 21 and an aromatics content as claimed in claim 24.~~
- 30 26.21. A synthetic middle distillate cut as claimed in ~~any one of claims 18 to 25~~, wherein the synthetic distillate is a FT product and the synthetic middle distillate cut is at least 60% biodegradeable within 28 days when using the Modified Sturm Test.
22. 22. A synthetic middle distillate cut as claimed in claim 2, wherein the synthetic distillate is a FT product and the synthetic middle distillate cut is at least 60% biodegradeable within 28 days when using the Modified Sturm Test.
- 35 27.23. A ~~biodegradable~~ diesel fuel composition including from 10% to 100% of a middle distillate cut as claimed in ~~any one of the preceding claims 1.~~

24. A diesel fuel composition including from 10% to 100% of a middle distillate cut as claimed in claim 2.

~~25. A biodegradable diesel fuel composition as claimed in claim 237, including from 0 to 90% of at least one other diesel fuel.~~

26. A diesel fuel composition as claimed in claim 24, including from 0 to 90% of at least one other diesel fuel.

~~27. A biodegradable diesel fuel composition as claimed in claim 27 or claim 28, including from 0 to 40% additives.~~

~~28. A biodegradable diesel fuel composition as claimed in any one of claims 27 to 29, wherein the additives include a lubricity improver.~~

~~29. A biodegradable diesel fuel composition as claimed in claim 30, wherein the lubricity improver comprises from 0 to 0.5% of the composition.~~

~~30. A biodegradable diesel fuel composition as claimed in claim 31, wherein the lubricity improver comprises from 0.00001% to 0.05% of the composition.~~

~~31. A biodegradable diesel fuel composition as claimed in claim 32, wherein the lubricity improver comprises from 0.0008% to 0.02% of the composition.~~

~~32. A biodegradable diesel fuel composition as claimed in any one of claims 23-28 to 33, wherein one of the other diesel fuels is US 2-D grade diesel fuel.~~

28. A diesel fuel composition as claimed in claim 243, wherein one of the other diesel fuels is US 2-D grade diesel fuel.

~~33. A biodegradable diesel fuel composition as claimed in any one of claims 238 to 33, wherein one of the other diesel fuels is CARB grade diesel fuel.~~

30. A diesel fuel composition as claimed in claim 24, wherein one of the other diesel fuels is CARB grade diesel fuel.

~~34. 31. A process for producing a readily biodegradable synthetic middle distillate, the process including:~~

- (a) separating the products obtained from synthesis gas via the FT synthesis reaction into one or more heavier fraction and one or more lighter fraction;
- (b) catalytically processing the one or more heavier fraction under conditions which yield mainly middle distillates;
- (c) separating the middle distillate product of step (b) from the lighter product and heavier product that are also produced in step (b); and
- (d) blending the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof.

~~37. 32. A process for producing a synthetic middle distillate as claimed in claim 301, wherein the catalytic processing of step (b) is a hydroprocessing step.~~

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~~33. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the additional step of hydrotreating is an additional step.~~

~~34. A process for producing a synthetic middle distillate as claimed in claim 31, including one or more additional step of fractionating at least some of the one or more lighter fraction of step (a), or products thereof, prior to step (d).~~

~~35. A process for producing a synthetic middle distillate as claimed in claim 31, including the additional step of hydrotreating at least some of the one or more light fraction of step (a), or products thereof, prior to step (d).~~

~~36. A process for producing a synthetic middle distillate as claimed in claim 31, including the additional step of hydrotreating at least some of the one or more light fraction of step (a), or products thereof, prior to step (d).~~

~~37. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more heavier fraction of step (a) boils above about 270°C.~~

~~38. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more heavier fraction of step (a) boils above about 300°C.~~

~~39. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more lighter fraction boils in the range C₅ to the boiling point of the heavier fraction.~~

~~40. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more lighter fraction boils in the range 160°C to 270°C.~~

~~41. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) boils in the range 100°C to 400°C.~~

~~42. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) boils in the range 160°C to 370°C.~~

~~43. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is a diesel fuel.~~

~~44. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is a diesel fuel.~~

~~45. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is a diesel fuel.~~

~~46. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio selected to provide a diesel fuel having a required specification.~~

~~47. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is obtained by mixing the middle distillate fraction~~

obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of between 1:1 and 9:1.

50.47. A process for producing a synthetic middle distillate as claimed in claim 46⁹, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of between 2:1 and 6:1.

51.48. A process for producing a synthetic middle distillate as claimed in claim 50.47, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of 84:16.

~~52. A synthetic middle distillate cut, substantially as herein described and illustrated.~~

~~53. A biodegradable synthetic middle distillate cut, substantially as herein described and illustrated.~~

~~54. A biodegradable diesel fuel composition, substantially as herein described and illustrated.~~

~~55. A process for producing a readily biodegradable synthetic middle distillate, substantially as herein described and illustrated.~~

~~56. A new synthetic middle distillate cut, biodegradable synthetic middle distillate cut, biodegradable diesel fuel composition or a new process for producing a readily biodegradable synthetic middle distillate, substantially as herein described.~~

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: De Haan, et al.

Art Unit: To Be Assigned

Serial No.: To Be Assigned

Examiner: To Be Assigned

Filed: Herewith

Atty. Docket: 0264-0002

For: Biodegradable Middle Distillates and
Production Thereof

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application, Applicant herewith respectfully requests the following amendments:

IN THE SPECIFICATION:

On page 1 of the international application, please substitute the last paragraph with the following:

The prior art teaches in ZA 96/9890 that high biodegradability of hydrocarbon base oils could be derived from the presence of predominantly mono-methyl branching on the paraffinic carbon backbone. US 5,498,596 discloses a non-toxic, biodegradable well fluid comprising 98% (mass) n-paraffins and less than 1% (mass) monocyclic aromatics as well as other olefinic components. The biodegradability of the well fluid in the US patent can not be related back to the nature of the paraffinic molecules due to the fact that biodegradability is enhanced through branching and not through linear n-paraffinic molecules. Further, WO 92/14804 discloses a low aromatic diesel fuel which comprises mainly a mixture of hydrocarbons containing not more than 1% by volume of

aromatic type hydrocarbons and less than 0.05% sulfur or sulfur compounds. The fuel is disclosed as reducing unwanted emissions and improving operational performance. The disclosure however does not address the issue of biodegradability. Still further, WO 97/14769 discloses diesel fuels having excellent lubricity, oxidative stability and high cetane number produced from the non-shifting Fischer-Tropsch process. Again no mention is made regarding biodegradability and the disclosure of oxidative stability would indicate against biodegradability.

Also on page 1 of the international application, please replace the final paragraph with the following:

Surprisingly, it has now been found, that a low aromatics content and a relatively high iso-paraffins to n-paraffins ratio contributes to ready biodegradability of middle distillates, such as diesel fuel.

On page 2 of the international application, please replace the first, second and third paragraphs with the following:

Thus, according to a first aspect of this invention, there is provided a biodegradable middle distillate cut, such as a diesel fuel, having an aromatics content of less than 9 mass%, as determined by the ASTM D 5186 or IP 391 test method.

The synthetic middle distillate cut may have less than 8.99 mass% monocyclic aromatics content.

The synthetic middle distillate cut may have less than 0.01 mass% polycyclic aromatics.

Also on page 2, please replace paragraph 6 with the following:

According to a second aspect of the invention, the synthetic middle distillate cut includes more than 50 mass% isoparaffins, wherein the isoparaffins consist predominantly of methyl and/or ethyl and/or propyl branched isoparaffins.

On page 3 of the international application, please replace 2 and 3 with the following:

The isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 20 mass% straight run component may be between 1.5:1 and 3.5:1.

The isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 10 mass% straight run component may be between 2.3:1 and 4.3:1.

Also on page 3, please replace paragraph 7 with the following:

In a useful embodiment, at least 30% (mass) of the isoparaffins are mono-methyl branched.

On page 6 of the international application, please replace paragraph 5 with the following:

According to a fifth aspect of the invention, there is provided a biodegradable diesel fuel composition including from 10 mass% to 100 mass% of a middle distillate cut as described above.

On page 7 of the international application, please replace paragraphs 1-4 with the following:

The biodegradable diesel fuel composition may include from 0 to 90 mass% of another diesel fuel, such as conventional commercially available diesel fuel.

The biodegradable diesel fuel composition may include from 0 to 10 mass% additives.

The additives may include a lubricity improver.

The lubricity improver may comprise from 0 to 0.5 mass% of the composition, typically from 0.00001mass% to 0.05 mass% of the composition. In a particularly useful

embodiment, the lubricity improver comprises from 0.00 mass% to 0.02 mass% of the composition.

On page 8 of the international application, please replace the final paragraph with the following:

The invention extends to an essentially non-polluting, readily biodegradable diesel fuel composition comprising of a mixture of normal paraffins (n-paraffins) and iso-paraffins in the typical diesel range from 160-370°C, having an iso-paraffin:n-paraffin mass ratio from about 2:1 to about 12:1, more typically from 2:1 to 6:1, and the iso-paraffins of the mixture contain greater than 30 mass%, based on the total mass of the iso-paraffins in the mixture, of mono-methyl species, with the balance consisting mainly of ethyl and/or dimethyl branched species. These iso-paraffins contained in a mixture with minor amounts of aromatics and other materials, contribute to a product from which readily biodegradable diesel fuels can be obtained.

IN THE CLAIMS:

Please substitute the original claims 1-56 with the following claims:

1. A synthetic middle distillate cut having less than 9 mass%, as determined according to IP 391 or ASTM D 5186 standards, aromatics content, the synthetic middle distillate cut having less than 8.99 mass% monocyclic aromatics content and less than 0.01 mass polycyclic aromatic content.
2. A synthetic middle distillate cut as claimed in claim 1, having an isoparaffins to n-paraffins mass ratio of between about 1:1 to about 9:1.
3. A synthetic middle distillate cut as claimed in claim 2, wherein the isoparaffins to n-paraffins mass ratio is between about 2:1 to about 6:1.
4. A synthetic middle distillate cut as claimed in claim 2, wherein the isoparaffins to n-paraffins mass ratio is 4:1.
5. A synthetic middle distillate cut as claimed in claim 1, wherein the synthetic distillate is derived from a FT primary product.
6. A synthetic middle distillate cut as claimed in claim 2, comprising more than 50 mass% isoparaffins, wherein the isoparaffins are predominantly methyl and/or ethyl and/or propyl branched.
7. A synthetic middle distillate cut as claimed in claim 2, wherein the gradient of an isoparaffins to n-paraffins mass ratio profile of the synthetic middle distillate cut increases from about 1:1 for C₈ to 8.54:1 for C₁₅ and decrease again to about 3:1 for C₁₈.
8. A synthetic middle distillate cut as claimed in claim 7, wherein a fraction of the synthetic middle distillate cut in the C₁₀ to C₁₈ carbon number range has a higher ratio of isoparaffins to n-paraffins than a C₈ to C₉ fraction of the synthetic middle distillate cut.
9. A synthetic middle distillate cut as claimed in claim 8, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction is between 1:1 and 9:1.

10. A synthetic middle distillate cut as claimed in claim 7, wherein the isoparaffins to n-paraffins mass ratio is about 8.54:1 for a C₁₅ fraction of the synthetic middle distillate cut.
11. A synthetic middle distillate cut as claimed in claim 7, wherein a C₁₉ to C₂₄ fraction of the middle distillate cut has a mass ratio range of isoparaffins to n-paraffins of between 3.3:1 and 5:1.
12. A synthetic middle distillate cut as claimed in claim 11, wherein the C₁₉ to C₂₄ fraction of the middle distillate cut has a mass ratio range of isoparaffins to n-paraffins of between 4:1 and 4.9:1.
13. A synthetic middle distillate cut as claimed in claim 7, wherein the mass ratio of isoparaffins to n-paraffins is adjusted by controlling the blend ratio of hydrocracked to straight run components of the synthetic middle distillate cut.
14. A synthetic middle distillate cut as claimed in claim 13, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 30 mass% straight run component is between 1:1 and 2.5:1.
15. A synthetic middle distillate cut as claimed in claim 13, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 20 mass% straight run component is between 1.5:1 and 3:5:1.
16. A synthetic middle distillate cut as claimed in claim 13, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having 10 mass% straight run component is between 2.3:1 and 4.3:1.
17. A synthetic middle distillate cut as claimed in claim 13, wherein the isoparaffins to n-paraffins mass ratio of the C₁₀ to C₁₈ fraction having substantially only a hydrocracked component is between 4:1 and 9:1.
18. A middle distillate cut as claimed in claim 6, wherein at least some of the isoparaffins are di-methyl branched.
19. A middle distillate cut as claimed in claim 6, wherein at least 30 mass% of the isoparaffins are mono-methyl branched.
20. A middle distillate cut as claimed in claim 19, wherein at least some of the isoparaffins are ethyl branched.

21. A synthetic middle distillate cut as claimed in claim 1, wherein the synthetic distillate is a FT product and the synthetic middle distillate cut is at least 60% biodegradeable within 28 days when using the Modified Sturm Test.
22. A synthetic middle distillate cut as claimed in claim 2, wherein the synthetic distillate is a FT product and the synthetic middle distillate cut is at least 60% biodegradeable within 28 days when using the Modified Sturm Test.
23. A diesel fuel composition including from 10% to 100% of a middle distillate cut as claimed in claim 1.
24. A diesel fuel composition including from 10% to 100% of a middle distillate cut as claimed in claim 2.
25. A diesel fuel composition as claimed in claim 23, including from 0 to 90% of at least one other diesel fuel.
26. A diesel fuel composition as claimed in claim 24, including from 0 to 90% of at least one other diesel fuel.
27. A diesel fuel composition as claimed in claim 23, wherein one of the other diesel fuels is US 2-D grade diesel fuel.
28. A diesel fuel composition as claimed in claim 24, wherein one of the other diesel fuels is US 2-D grade diesel fuel.
29. A diesel fuel composition as claimed in claim 23, wherein one of the other diesel fuels is CARB grade diesel fuel.
30. A diesel fuel composition as claimed in claim 24, wherein one of the other diesel fuels is CARB grade diesel fuel.
31. A process for producing a readily biodegradable synthetic middle distillate, the process including:
 - (a) separating the products obtained from synthesis gas via the FT synthesis reaction into one or more heavier fraction and one or more lighter fraction;
 - (b) catalytically processing the one or more heavier fraction under conditions which yield mainly middle distillates;
 - (c) separating the middle distillate product of step (b) from the lighter product and heavier product that are also produced in step (b); and

- (d) blending the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof.
32. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the catalytic processing of step (b) is a hydroprocessing step.
33. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the catalytic processing of step (b) is a hydrocracking step.
34. A process for producing a synthetic middle distillate as claimed in claim 31, including one or more additional step of fractionating at least some of the one or more lighter fraction of step (a), or products thereof, prior to step (d).
35. A process for producing a synthetic middle distillate as claimed in claim 31, including the additional step of hydrotreating at least some of the one or more light fraction of step (a), or products thereof, prior to step (d).
36. A process for producing a synthetic middle distillate as claimed in claim 33, including the additional step of hydrotreating at least some of the one or more light fraction of step (a), or products thereof, prior to step (d).
37. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more heavier fraction of step (a) boils above about 270°C.
38. A process for producing a synthetic middle distillate as claimed in claim 37, wherein the one or more heavier fraction of step (a) boils above about 300°C.
39. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more lighter fraction boils in the range C₅ to the boiling point of the heavier fraction.
40. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the one or more lighter fraction boils in the range 160°C to 270°C.
41. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) boils in the range 100°C to 400°C.
42. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) boils in the range 160°C to 370°C.
43. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is a diesel fuel.

44. A process for producing a synthetic middle distillate as claimed in claim 36, wherein the product of step (d) is a diesel fuel
45. A process for producing a synthetic middle distillate as claimed in claim 31, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio selected to provide a diesel fuel having a required specification.
46. A process for producing a synthetic middle distillate as claimed in claim 45, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of between 1:1 and 9:1.
47. A process for producing a synthetic middle distillate as claimed in claim 46, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of between 2:1 and 6:1.
48. A process for producing a synthetic middle distillate as claimed in claim 47, wherein the product of step (d) is obtained by mixing the middle distillate fraction obtained in step (c) with at least a portion of the one or more lighter fraction of step (a), or products thereof, in a volume ratio of 84:16.

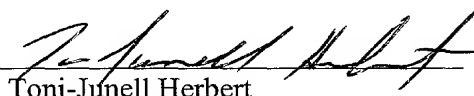
REMARKS

A marked-up version of the amendments is enclosed for your reference. It is respectfully requested that the Examiner enter these amendments prior to examining the application on its merits.

Respectfully submitted,

SHANKS & HERBERT

By:



Toni-Junell Herbert

Reg. No. 34,348

Date:

3/21/01

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COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below, next to my name. I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled BIODEGRADABLE MIDDLE DISTILLATES AND PRODUCTION THEREOF the specification of which:

X is attached hereto.
X was filed on March 21, 2001
 as United States Application Number 09/787,641
 or PCT International Application Number _____
 and was amended on _____
 (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
<u>ZA 98 9037</u> (Number)	<u>South Africa</u> (Country)	<u>5 October 1998</u> (Day/Month/Year Filed)	<u>X</u> Yes	<u> </u> No
<u>PCT/ZA99/00094</u> (Number)	<u>PCT</u> (Country)	<u>17 September 1999</u> (Day/Month/Year Filed)	<u>X</u> Yes	<u> </u> No
<u> </u> (Number)	<u> </u> (Country)	<u> </u> (Day/Month/Year Filed)	<u> </u> Yes	<u> </u> No

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

<u> </u> (Application Number)	<u> </u> Filing Date
<u> </u>	<u> </u>

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37,

09787641 0000004

Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	Filing Date	(Status – patented, pending, abandoned)
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(Application Number)	Filing Date	(Status – patented, pending, abandoned)
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(Application Number)	Filing Date	(Status – patented, pending, abandoned)
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I hereby appoint Mark R. Shanks Registration No. 33,781, Toni-Junell Herbert, Registration No. 34,348, Joseph G. Contrera, Registration No. 44,628, David W. Woodward, Registration No. 35,020, Keith D. Hutchinson, Registration No. 43,687, Shelly Guest Cermak, Registration No. 39,571, Suzannah Sundby, Registration No. 43,172, and David Steffes, Registration No. 46,042 of SHANKS & HERBERT, telephone (703) 683-3600, with a mailing address at:

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Alexandria, VA 22314

with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

The undersigned hereby authorizes the U.S. Attorneys named herein to accept and follow instructions from undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney or patent agent, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.

Full Name of Sole/First Inventor: Robert DeHaan

Inventor's Signature: _____ Date: _____

Residence: Sasolburg, South Africa Citizenship: South Africa
(City, State) (Country)

Post Office Address: 25 Felixstowe Street, Sasolburg 9570, South Africa

Full Name of Second/Joint Inventor: Luis Pablo Dancuart

Inventor's Signature: _____ Date: _____

Residence: Sasolburg, South Africa Citizenship: South Africa
(City, State) (Country)

Post Office Address: 20 Lombard Street, Vaalpark, Sasolburg 9570, South Africa

42P

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below, next to my name. I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled BIODEGRADABLE MIDDLE DISTILLATES AND PRODUCTION THEREOF the specification of which:

☒ is attached hereto.
☐ was filed on March 21, 2001
as United States Application Number 09/787,641
or PCT International Application Number _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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<u> </u> (Number)	<u> </u> (Country)	<u> </u> (Day/Month/Year Filed)	<u> </u> Yes	<u> </u> No

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

<u>(Application Number)</u>	<u>Filing Date</u>
<u> </u>	<u> </u>

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37,

Full Name of Third Inventor: Mark Jan Prins

Inventor's Signature: _____ Date: _____

Residence: Sasolburg, South Africa Citizenship: South Africa
(City, State) (Country)

Post Office Address: 61 Waterson Street, Sasolburg 9570, South Africa

Full Name of Fourth Inventor: Ewald Watermeyer DeWet

Inventor's Signature: Ewald Watermeyer DeWet Date: May 9, 2001

Residence: Vanderbijlpark, South Africa Citizenship: South Africa
(City, State) (Country)

Post Office Address: 24 Beethoven Street, Vanderbijlpark 1911, South Africa

Patented by the U.S. Patent and Trademark Office

Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	Filing Date	(Status – patented, pending, abandoned)
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(Application Number)	Filing Date	(Status – patented, pending, abandoned)
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Alexandria, VA 22314

with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

The undersigned hereby authorizes the U.S. Attorneys named herein to accept and follow instructions from undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney or patent agent, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.

Full Name of Sole/First Inventor: Robert DeHaan

Inventor's Signature: Robert de Haan

Date: May 9, 2001

Residence: Sasolburg, South Africa
(City, State)

Citizenship: South Africa
(Country)

Post Office Address: 25 Felixstowe Street, Sasolburg 9570, South Africa

Full Name of Second/Joint Inventor: Luis Pablo Dancuart

Inventor's Signature: Luis Pablo Dancuart

Date: May 9, 2001

Residence: Sasolburg, South Africa
(City, State)

Citizenship: South Africa
(Country)

Post Office Address: 20 Lombard Street, Vaalpark, Sasolburg 9570, South Africa

3W

Full Name of Third Inventor: Mark Jan Prins

Inventor's Signature: [Signature]

Date: 23/4/2001

Residence: Sasolburg, South Africa
(City, State)

Citizenship: South Africa
(Country)

Post Office Address: 61 Waterson Street, Sasolburg 9570, South Africa

Full Name of Fourth Inventor: Ewald Watermeyer DeWet

Inventor's Signature: _____

Date: _____

Residence: Vanderbijlpark, South Africa
(City, State)

Citizenship: South Africa
(Country)

Post Office Address: 24 Beethoven Street, Vanderbijlpark 1911, South Africa

MJP